



Designing zone tillage systems for organic vegetables – Summer 2018

- Zone tillage (ZT) targets disturbance to the planting row and reduces tilled area by at least 50% when compared to conventional tillage.
- In northern climates, ZT can balance some of the soil-improving benefits of no-till with the well-known advantages of tillage: finer seed bed, soil warming and aeration.
- Zone-till needs to be adapted for organic systems to overcome common barriers to reduced tillage - high weed pressure, interference from surface residue, and low soil nitrogen (N) availability.
- Successful farm adoption requires system-level changes: selecting specific crops in a rotation, planning cover crop management, and acquiring and/or modifying tools that work in moderate to high residue conditions.



Stacking tillage tools can save time for field prep and reduce labor and fuel needs. Deep zone tillage rips a narrow channel below compacted zones to break up pans (plow, disc, rototiller) and loosen soil in a ~12” zone to prepare a seedbed, often in one pass. Components can include:

- 1) coulters for cutting residue
- 2) row cleaners for raking residue aside
- 3) deep shank for alleviating compaction in the planting row
- 4) wavy coulters/discs for filling the slot and building the zone
- 5) cultipacker wheels/rolling baskets for breaking clods and firming soil.

Equipment combinations can be fit the farm. The tools used and depth of operation will depend on farm-scale, access to equipment, field history and soils. Generally, deep zone units require 4WD and 30-40 HP per shank.

- A Yeoman’s plow requires a custom-built finishing unit (or a second pass) but is a lighter unit and shanks can be moved around easily to allow flexibility for different crop spacing.
- Other tools for shallow operation are available or can be constructed.
- At smaller scales, a subsoiler in combination with a walk-behind rototiller in-row is an option.





Winter hardy cover cropping for zone tillage: putting the pieces together to maximize cover crop benefits

Much attention has been given to cover crop-mulching with winter rye grown in-place. Winter rye can be planted in late fall and has high biomass potential for suppressing weeds but it can suck up moisture in a dry spring and tie up soil N for heavy feeding vegetables. The residue can also cause trouble without the appropriate tools, especially as weeds escape. Research on different winter hardy cover crop mixes and mulch management practices provides lessons to share and build upon to support zone-till adoption.

Principle – Cover crops can provide additive benefits (e.g. weed suppression, organic matter, soil cover, active roots) when combined with reduced tillage practices.

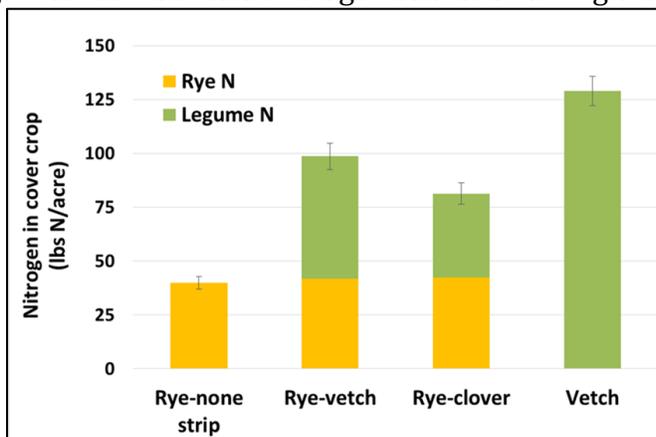
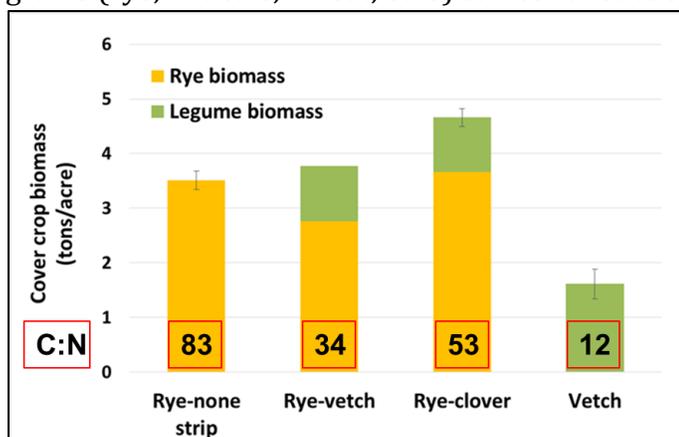
Question - How do we maximize cover crop benefits for zone-till and balance weed, nitrogen, and residue management challenges to be successful?

Zone tillage is a system that goes beyond the tillage tool.

Key decision points

- **Late Aug to mid-Sept** -> **Cover crop selection and planting** – e.g. cover crop species (cereals, cereal + legume mixtures, or legumes), planting date and seeding rate, strip or mixed planting
- **Late May to mid-June** -> **Cover crop management** – e.g. mowing and leaving in-place as mulch, repeated mowing (2-3x), cover crop removal (cut and carry), tool used for mechanical termination
- **Mid-June to early July** -> **Tillage and cash crop planting** – e.g. intensity of tillage, row cleaners, planter
- **July to Aug** -> **Cultivation** – e.g. tool types (high or low residue), timing and frequency

Maximizing cover crop growth in spring provides organic matter and legume-nitrogen available to the crop. Cover crops grown to anthesis can be killed mechanically without tillage. The timing is easier to determine in monocultures (e.g. winter rye or hairy vetch alone) and it's harder to optimize for all species when planted in mixtures. Mowing hairy vetch at full-flower will minimize risk for regrowth and seed production. Legumes (hairy vetch, crimson clover, Austrian winter pea) planted alone or with cereal grains (rye, triticale, wheat, oats) can contribute significant amounts of nitrogen to the following crop.



Cover crops and mowing equipment effect residue interference for planting. Row cleaners are very important for building clean planting zones in high residue and work best after flail mowing. Flail mowers finely chop and lay biomass evenly compared to a rotary mower and front or side-mounted units avoid driving over cover crops and give a more complete kill. Belowground rye residue, roots and crowns, can lead to a rougher planting conditions when compared to finer-rooted vetch.

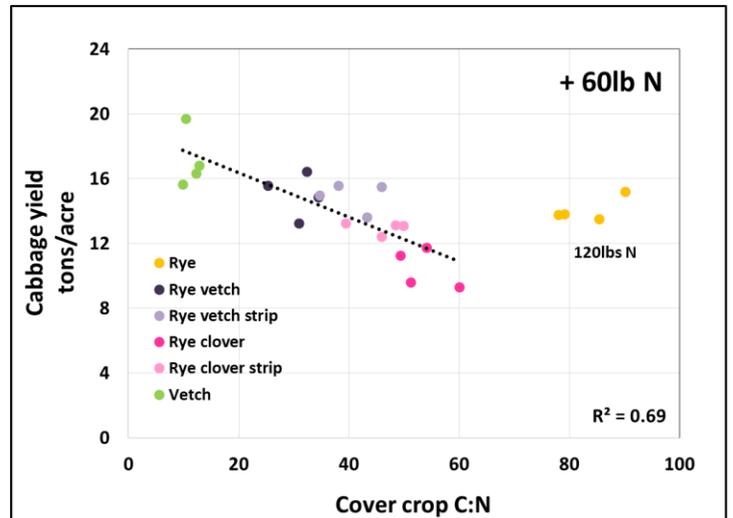
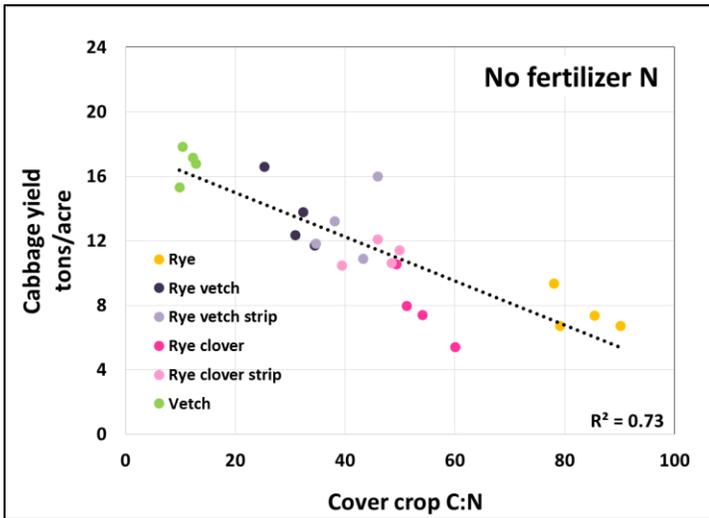


Mowing and row cleaning in winter rye

High-residue cultivation tools are critical for controlling weeds in mulch. Mowed cover crop mulches don't provide season-long weed control (≤ 30 days) but can reduce cultivations (1-2 depending on the year). Rolling cultivator tools, disc and spider gangs, can work despite surface residues and be effective for between-row weeds while finger weeders have shown some success for in-row weed control. Residue from hairy vetch alone breaks down quickly and provides little mulch benefit but can be cultivated with a range of tools.



Crop yields are related to nitrogen availability from the cover crop and not limited by reduced tillage. Brassicas are very responsive to nitrogen. Vetch is a big nitrogen contributor and has led to high yields without added fertilizer in both wet and dry years (Howard loam). Vetch and winter rye –vetch mixes can produce similar or greater yields than winter rye with 120lbs of fertilizer nitrogen. Zone-tilled vetch has produced similar yields to rototilled vetch.



Considerations for trialing zone-till practices on the farm:

- Plan for large seeded vegetable crops (e.g. sweet corn, beans) and/or transplants (e.g. brassicas, cucurbits) because they don't require a fine seed bed.
- Try cucurbits for a single-row zone-till system after winter hardy cover crops. Wider between-row spacing makes for less zones and edge to manage. There is also room to mow cover crops repeatedly during early crop growth if regrowth is a problem.
- When using winter rye or mixtures dominated by cereal grains, follow with low nitrogen demanding crops (e.g. beans). Leaving the strips in the cover crop (blocking off planter) can help reduce residue in the planting row.
- Use cover crop mixtures dominated by legumes and a lower cereal seeding rate for less residue. They are easier to plant into and cultivate without highly specialized tools.
- Try an alternative management with cereal-legume mixes for more biomass with less residue. Mow several times over spring, then subsoil or zonebuild in the planting zone in combination with shallow surface tillage (disc or rototiller).



Find more project resources at smallfarms.cornell.edu

IDEAS or QUESTIONS? Contact Ryan Maher, Cornell Small Farms Program, rmm325@cornell.edu.

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